Stereotactic QA Solutions and Results from a Multi-Institution Stereotactic QA Study Using a Novel Stereotactic Array

Jennifer Hamilton, ME, DABR
Disclosures:

- Clinical physicist employed at Sun Nuclear
Assessing Adoption Rates

Results from a 2016 QADS Survey

How would you describe your center’s SRS/SBRT program?

a. Currently nonexistent, no plans to begin
b. Currently nonexistent, interested in developing
c. Active, 10-30% of patient volume
d. Active, >30% of patient volume

Adoption

- 70.3%
- 16.2%
- 10.8%
- 2.7%
Assessing Suitability of Current QA Tools

Do you believe current QA tools are sufficient for **commissioning and routine machine QA** for your SRS/SBRT program?

<table>
<thead>
<tr>
<th>Suitable?</th>
<th>43.6%</th>
<th>56.4%</th>
</tr>
</thead>
</table>

Do you believe current QA tools are sufficient for **patient-specific QA** for your SRS/SBRT program?

<table>
<thead>
<tr>
<th>Suitable?</th>
<th>63.9%</th>
<th>36.1%</th>
</tr>
</thead>
</table>
# Challenges with SRS Patient Specific QA Devices

<table>
<thead>
<tr>
<th>Film</th>
<th>SRS MapCHECK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requires strict handling and processing protocols</td>
<td>Fast and straightforward initial setup, less user dependent</td>
</tr>
<tr>
<td>Delay between measurement and result</td>
<td>Results available immediately after measurement</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EPID</th>
<th>SRS MapCHECK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-linear response with field size</td>
<td>Corrected for small-field over-response</td>
</tr>
<tr>
<td>Designed as imager</td>
<td>Designed as dosimeter</td>
</tr>
<tr>
<td>Measurements always normal to the beam</td>
<td>QA measurements in patient geometry, including couch kicks (currently +/- 45°)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ionization Chambers</th>
<th>SRS MapCHECK</th>
</tr>
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<tbody>
<tr>
<td>Single-point measurement</td>
<td>1013-point 2D array, 2.5 mm spacing, 7.7 x 7.7 cm² area</td>
</tr>
<tr>
<td>Volume averaging (&gt;1mm)</td>
<td>0.007 mm³ detector active volume</td>
</tr>
</tbody>
</table>
**SRS MapCHECK™**

- High-density diode array for stereotactic patient QA measurements
- Small-field digital film replacement for patient-specific QA and end-to-end testing
  - Array Size: 77 x 77mm
  - Detectors: 1,013
  - Active Detector Area (mm): 0.48 x 0.48
    - Volume 0.007 mm$^3$
  - Detector spacing: 2.47 mm
    - 5 Diodes in 5 mm cone
  - **No Film needed!**
SRS MapCHECK and SNC Patient overview

- High-density diode array for stereotactic patient QA measurements
- Designed for use in StereoPHAN phantom
- Supported by SNC Patient software as part of an end-to-end testing solution
- Software corrections for well-known diode response characteristics:
  - Angular Dependence
  - Field size
  - Temperature
  - Dose rate
Meets Task Group requirements

- **Task Group 101** - Stereotactic body radiation therapy
  - End-to-End test annually
  - <1mm detector size due to steep gradients

Pros/Cons of SRS detectors:

- **Ion chambers**
  - Relatively large volumes/dimensions
  - All diameters >1mm – A16 @ 2.4mm diameter
  - Small volume readings can be unreliable

- **Film**
  - High resolution
  - Dose errors >1%

- **Stereotactic diodes**
  - ≤ 1 mm high spatial resolution
  - Potential energy and field size dependences

- **Task Group 218** – IMRT/VMAT QA
  - Recommends True Composite measurements
  - Recommends against Perpendicular Composite
    - Masks errors
  - Angular Dependence corrections applied
Validation that the SRSMC is TG-218 compliant:

- True Composite
- Applies appropriate Angular Dependency factors
- Studied **Output vs. W2/film, Dose Rate, Angular Dependence** – with and without corrections
StereoPHAN™

- Cylinder with 85mm x 85mm x 118.2mm cavity
- Cylinder slide to remove inserts
- Film insert
- MR/CT insert
- MRI signal generator insert
- Leveling base
- Ion chamber insert
- MR/CT/marker filler insert

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Multi-Institution Stereotactic QA Results Using SRS MapCHECK

Lena Tirpak, Ph.D. and Mark Rose, Ph.D.
Sun Nuclear Corporation
October 2018
Multi-Institution Stereotactic QA Results Using SRS MapCHECK

Clinical Performance Evaluation of SRS MapCHECK:
• SRS MapCHECK was tested at 8 clinical sites

• 85 stereotactic patient QA measurements were collected
  o Single iso Multi-met plans
  o Intracranial SRS and SBRT—PTV sizes as small as 0.75 cc
  o VMAT, IMRT, and Cones

• Treatment delivery devices
  o Varian and Elekta linacs
  o 6 MV, 6FFF, 10 MV, 10FFF
Multi-Institution Stereotactic QA Results Using SRS MapCHECK

- SRS MapCHECK absolute dose accuracy was evaluated against:
  - Radiochromic Film – 51 of 85 measurements
  - TPS dose – 85 of 85 measurements
  - Evaluation parameters:
    › gamma analysis (absolute dose)
    › 3%/1mm, global

- **Results:**
  - Gold Standard – film
  - Mean 3%/1mm gamma pass rate:
    - Vs. film: 95.5%
    - Vs. TPS: 93.1%
  - 80% of comparisons against film exceed 95% pass rate
  - 30% of comparisons against film exceed 99% pass rate
  - SRS MapCHECK is an adequate film substitute

Cumulative histogram of SRS MC analysis results against film and against TPS. Only those measurements for which both film and TPS data were available are included.
Treatment plan characteristics

- **Field Size → Mean MLC segment size**
  - Equivalent square size defined as \(4*A/P\), where \(A\) is the segment area and \(P\) is segment perimeter
  - Calculated for each control point from MLC positions in DICOM RT Plan

- **Complexity → Modulation complexity score**
  - Variation of MCS proposed by McNiven* et al.
  - Consider segment area variability and a ratio of segment area to its perimeter
  - What it means: high MCS = low modulation complexity
    - \(MCS = 1\) ➔ circular collimator (SRS cone)
    - \(0.5 < MCS < 1\) ➔ sliding window IMRT/VMAT, conformal arc, square and rectangular fields
    - \(0.1 < MCS < 0.5\) ➔ step-and-shoot, small-segment IMRT/VMAT
    - \(MCS < 0.1\) ➔ highly-modulated, “hard-driven” plans; multiple very small segments

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SRS MapCHECK Results

- 13 SRSMC measurements fail vs TPS
- 4 SRSMC measurement fail vs film
  - 2 were true SRSMC failures
  - 1 delivery reproducibility issues with Linac
  - 1 low-dose film error

- TPS Mean MLC segment size
  - Mean: 13 mm
  - Range: 4.8 to 50.1 (not shown)

- Segment Size Correlation with Failures:
  - SRSMC vs. Film – no apparent trend with segment size
  - SRSMC vs. TPS – more failures below 15 mm
    - TPS output factors likely at fault
Treatment plan characteristics

• Modulation complexity score (MCS)
  o Pass rates are reduced for MCS < 0.2 (High complexity plans)
    ‣ for film and TPS
  o Reduced SRSMC pass rates vs. film are likely due to either delivery reproducibility errors or SRS MC performance
Most common errors found with SRS MC and Film

- Incorrect Small field Output Factors with both MLC and Cone programs
  - One site had 13.5% dose error due to incorrect small field factors – 10FFF

- TPS grid size
  - Too large voxels size in TPS calc caused errors; recalc at 1x1x1mm3 passed
  - SRS MC caught the errors

- Small segment size/high complexity
  - Note: Larger PTV does not mean that small-field dosimetry is not a concern in planning
  - Errors weren’t dependent on PTV overall size (0.75cc PTV passed), but rather on high modulation
Case studies – Case I

- Intracranial Tx - single 20-mm target
- Conformal arc, 6 FFF
- Mean MLC segment size: 20 mm
- Low complexity (MCS score: 0.7)

- SRS vs Film
  - 3%/1mm absolute gamma - 99.7%
  - Absolute dose is within 1.5%
- SRS vs. TPS
  - 3%/1mm absolute gamma - 87.9%
    - Relative agreement: 99.6%
    - Absolute dose is 5% high relative to TPS
- Error Source – Likely a TPS Output Factor error
Case Studies – Case II

- Intracranial - **single 8mm target**, 10 MV FFF
- Mean MLC segment size: **7.3, 8.3mm (small)**
- Low complexity (0.82 MCS)

<table>
<thead>
<tr>
<th>Field</th>
<th>Mean segment size</th>
<th>MCS</th>
<th>CAX Dose Difference (SRS MC – TPS)</th>
<th>CAX Dose Difference (SRS MC – Film)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field 1</td>
<td>7.3 mm</td>
<td>0.82</td>
<td>-13.2%</td>
<td>0.6%</td>
</tr>
<tr>
<td>Field 2</td>
<td>8.3 mm</td>
<td>0.82</td>
<td>-0.2%</td>
<td>2.3%</td>
</tr>
</tbody>
</table>

- Each field was measured twice
  - Field 1 error was reproduced both times
- **Error Source – Likely TPS output factors & Deliverability**
  - Output Factors change rapidly below 10mm
  - A small FS delivery error = large dose difference

Sample output factor curve for 10 MV FFF beam, Varian TrueBeam

Case Studies – Case III

- Single iso/multi-met treatment - 6 PTVs, 6 MV beam - Particularly challenging to plan, deliver, and measure
- Measurement plane (purple) skims through dose falloff region. (70% isodose surface is shown in yellow.)
- This plan had the Smallest MLC segment size (5.1, 4.9, 6.5 mm) and highest complexity score (0.01!)
- Gamma Pass rates are almost all failing

<table>
<thead>
<tr>
<th>Field</th>
<th>Mean segment size (mm)</th>
<th>MCS</th>
<th>3%/1mm gamma SRS MC vs Film</th>
<th>3%/1mm gamma SRS MC vs TPS</th>
<th>3%/1mm gamma Film vs TPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field 1</td>
<td>5.1</td>
<td>0.01</td>
<td>81.6</td>
<td>80.7</td>
<td>72.6</td>
</tr>
<tr>
<td>Field 2</td>
<td>4.9</td>
<td>0.01</td>
<td>76.2</td>
<td>75.7</td>
<td>60.6</td>
</tr>
<tr>
<td>Field 3</td>
<td>6.5</td>
<td>0.01</td>
<td>90.1</td>
<td>92.8</td>
<td>87.8</td>
</tr>
</tbody>
</table>

Beam view of Field 1 (rendered by SNC 3DVH software). Graticule grid is 1 cm. Jaws are set to 21 cm x 16 cm. MLC leaf width is 4 mm.
Case Studies – Case III

- Dose difference between SRS MapCHECK and film is normally distributed
  - Negative dose offset indicates SRS MapCHECK under-response
  - Suspect out-of-field response non-linearity – this is a more pronounced effect in a highly modulated delivery than in more conformal plan
- Dose difference from TPS is similarly distributed for SRS MapCHECK and film
- Error Source – Suggests TPS calculation error or systematic delivery error, likely both!
  - MM Single Iso VMAT tax the TPS calculations, the delivery system, and the QA Device
  - For SRS MC, one solution is to do multiple planes through the center of the various Metastasis

*Film measurements were resampled onto SRS MC grid to facilitate comparison to TPS
Case Studies – Case IV

- This one’s easy 😊
- TPS data calculated on 3x3x3 mm³ dose grid
Case Studies – Case IV

- TPS data calculated on $1x1x1 \text{ mm}^3$ dose grid
- Large voxel size will reduce accuracy of the calculation
  - MLC segments are not calculated accurately – volume averaging
- Error Source – large Grid Size
Other Publications/Abstracts
SRSMC Publication

- **Compared SRSMC with EBT3 and PinPoint chamber**

- **CONCLUSIONS**: Our results indicate that the SRS MapCHECK can be used to verify the dosimetry for intracranial radiosurgery treatments with all fields composite at 0 degrees with **good responses for gamma analysis of (3%/1 mm), (2%/1.5mm) and (2%/1 mm)**.

- The ability of the SRS MapCHECK to simultaneously perform both relative and absolute dose measurements can simplify and reduce the SRS quality assurance workload.

- Furthermore, its interface makes the comparison to planning data easy and efficient. The **easy configuration and the immediate result** make that the SRS MapCHECK can be considered as an efficient tool that verifies the treatment with the configurations designed in this work.

<table>
<thead>
<tr>
<th>Case</th>
<th>PTV (cc)</th>
<th>Field Size X (cm)</th>
<th>Field Size Y (cm)</th>
<th>Mod. Factor</th>
<th>3%/1 mm</th>
<th>2%/1.5 mm</th>
<th>2%/1 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain 1</td>
<td>2.2</td>
<td>2.2</td>
<td>1.17</td>
<td>100%</td>
<td>97.1%</td>
<td>95.6%</td>
<td></td>
</tr>
<tr>
<td>Brain 2</td>
<td>1.25</td>
<td>3.0</td>
<td>1.23</td>
<td>100%</td>
<td>98.3%</td>
<td>98.3%</td>
<td></td>
</tr>
<tr>
<td>Brain 3</td>
<td>0.45</td>
<td>1.5</td>
<td>1.6</td>
<td>1.13</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Brain 4</td>
<td>2.33</td>
<td>2.2</td>
<td>1.13</td>
<td>98.3%</td>
<td>100%</td>
<td>96.6%</td>
<td></td>
</tr>
<tr>
<td>Brain 5</td>
<td>2.03</td>
<td>2.4</td>
<td>2.0</td>
<td>1.10</td>
<td>95.1%</td>
<td>95.1%</td>
<td>95.1%</td>
</tr>
<tr>
<td>Brain 6</td>
<td>1.01</td>
<td>2.2</td>
<td>2.0</td>
<td>1.19</td>
<td>94.4%</td>
<td>94.4%</td>
<td>94.4%</td>
</tr>
<tr>
<td>Brain 7</td>
<td>6.10</td>
<td>3.4</td>
<td>3.2</td>
<td>1.13</td>
<td>100%</td>
<td>94.4%</td>
<td>92.6%</td>
</tr>
<tr>
<td>Brain 8</td>
<td>12.48</td>
<td>4.2</td>
<td>4.2</td>
<td>1.44</td>
<td>99.3%</td>
<td>100%</td>
<td>95.8%</td>
</tr>
<tr>
<td>Brain 9</td>
<td>11.15</td>
<td>3.9</td>
<td>3.8</td>
<td>1.31</td>
<td>98.75%</td>
<td>98.7%</td>
<td>96.7%</td>
</tr>
</tbody>
</table>
Title: Commissioning SNC’s SRS MapCHECK diode array for small field dosimetry, St. George’s, New Zealand, Susana Oliveira et al.

Methods:

• SRS MapCHECK was characterized in terms of short-term reproducibility, linearity, dose rate and angular dependences for $5 \times 5 \, \text{cm}^2$ field sizes using an Elekta Synergy LINAC with a flattened beam and an energy of 6 MV. Output factors (OPFs) were compared with ionization chamber (IC) measurements.

Results:

• For all diodes within $\pm 2 \, \text{cm}$ of the array isocentre, the short-term reproducibility variation coefficient was within 0.2%.

• Linearity with respect to 100 MU was within 1% above 15 MU and within 2% from 5 MU.

• Measurements to quantify the dose-rate dependence showed an average variation of 1.3% from 60 MU/min to 480 MU/min.

• Angular dependence measurements resulted in an average relative difference to 0° for the central diode of -0.7% for 45° angles, -1.9% for 90°, and -0.2% for 180°.

• Averaged Output Factors results were within 1.1% in relation to the IC measurements for field sizes between $1 \times 1 \, \text{cm}^2$ and $7 \times 7 \, \text{cm}^2$.

Conclusion:

• SRS MapCHECK was well characterized and is suited to small field dosimetry and routine patient-specific QA for stereotactic treatments. So far, it shows very good agreement with the TPS QA plans for SRS.
NEW! Evaluation of a New Diode Array Dedicated to SRS/SBRT Commissioning and QA

Tuesday, September 18, 2018 // 12 PM U.S. ET

Commissioning and routine QA of small fields can be complex and new tools should be reviewed carefully. Join Remy Villeneuve, Ph.D., for a presentation on his experience in evaluating the new SRS MapCHECK™ for small field dosimetry.
Beta User Study

Evaluation of a New Diode Array
Dedicated to SRS/SBRT Commissioning and QA

Remy VILLENEUVE* - Nicolas GARNIER - Regis AMBLARD - Oreste ALLEGRINI - Benjamin SERRANO

Princess Grace Hospital Center - Monaco
Medical Physics and Radiation Protection Department
Evaluation of a New Diode Array
Dedicated to SRS/SBRT Commissioning and QA

Rémy VILLENEUVE - Nicolas GARNIER - Régis AMBLARD - Oreste ALLEGRI - Benjamin SERRANO

- **Linearity** CAX dose from 5 MU to 10000 MU with an ionisation chamber under the SRS MapCHECK (field size 5 x 5 cm²)
• Dose Rate dependence
  o Comparable with an ion chamber
  o Except <40 MU/min
• SRS MapCHECK and microDiamond compare well
• Eclipse seems to underestimate dose for small fields using MLCs
• SRS MapCHECK is a good tool for commissioning
Evaluation of a New Diode Array
Dedicated to SRS/SBRT Commissioning and QA

Rémy VILLENUEVE* - Nicolas GARNIER - Régis AMBLARD - Oreste ALLEGIRINI - Benjamin SERRANO

Portal Dosimetry

WARNING

µDiamond: not OK  Film: not OK  SRS MapCHECK: not OK  Octavius 1000SRS (PTW): not OK
• Conclusion: The agreement of PD to TPS mean dose in the high dose region was found to be dependent on target size. Film measurements did not exhibit size dependence. All PD plans passed the 3%/2 mm gamma analysis, but caution should be used when using PD to assess overall dosimetric accuracy of the treatment plan for small targets.

• Conclusion: Portal dosimetry measurements were found to be target size dependent and could deviate up to 8% from film measurements for the smallest targets evaluated. While portal dosimetry provides a quick method to evaluate SRS plans for gross error without the use of a specialized phantom, it does not provide an accurate method for determining the dosimetric accuracy of the plan when compared to film.
What’s New in SRS QA...
SRS MapCHECK // SNC Patient v8.3

Software Updates since Initial Release

- SNC Patient Software Updates
  - 8.1- Absolute Dose
  - 8.2- Non-Coronal Measurement
  - 8.3- Vertex Compatible - June 2019
SRS MapCHECK // SNC Patient v8.3 – coming June 2019

Upcoming Vertex Capabilities allow use with:
• Varian HyperArc
• CyberKnife
• Couch kicks +/- 90°
Whole Brain vs. Multi-Met Single Iso

RSS (docs) vs. Spring AAPM (physicists)
Case Studies – Case III

• Single iso/multi-met treatment - 6 PTVs, 6 MV beam - Particularly challenging to plan, deliver, and measure
• Measurement plane (purple) skims through dose falloff region. (70% isodose surface is shown in yellow.)
• This plan had the Smallest MLC segment size (5.1, 4.9, 6.5mm) and highest complexity score (0.01!)
• Gamma Pass rates are almost all failing

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Beam view of Field 1 (rendered by SNC 3DVH software). Graticule grid is 1 cm. Jaws are set to 21 cm x 16 cm. MLC leaf width is 4 mm.
Positioning errors: single vs multi target

Translational errors: Same effect

Rotational errors: Displacement varies with distance from point of rotation
Need for Multi-Met QA

• Used TPS to introduce errors, no mechanical measurements
• Induced 0.5° & 1.0° errors in Gantry, Collimator, and Couch
• “Based on the results of this study, we suggest a careful review by the clinical physicist of routine quality assurance tolerances for angular mechanical checks when using multifocal MVAT for metastatic disease.”
• “the stricter angular tolerance may necessitate a new method of measurement”
• Found errors to be greatest in Collimator>Gantry>Couch (negligible)
• Note this study assumes “perfect’ errors – real errors are likely to be larger
  o Systematic
  o Consistent/Uniform
  o Isolated
  o No Couch or Gantry Sag
  o No “walk out” errors

<table>
<thead>
<tr>
<th></th>
<th>Target coverage</th>
<th>V100%</th>
<th>D99%</th>
</tr>
</thead>
<tbody>
<tr>
<td>+/- 1.0° Coll</td>
<td>Ave errors</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>Max errors</td>
<td>33%</td>
<td>20%</td>
</tr>
<tr>
<td>+/- 1.0° Gantry</td>
<td>Ave errors</td>
<td>2%</td>
<td>4.5%</td>
</tr>
<tr>
<td></td>
<td>Max errors</td>
<td>18%</td>
<td>12%</td>
</tr>
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</table>
Need for Multi-Met QA

- Measurement-based study
- Noted that couch rotations caused the largest errors
  - This is expected; unlike previous TPS-based study
- Recommends offset distance of <6cm since this reaches 1mm error
  - Margins are most often 0-1mm

Winston-Lutz-Gao Test on the True Beam STx Linear Accelerator

Junfang Gao¹, Xiaqian Liu²

¹Northeast Louisiana Cancer Institute, Monroe, LA, USA
²Division of Pharmacy, The University of Texas MD Anderson Cancer Center, Houston, TX, USA

Email: Junfang.gao@cancerinstitute.com

Figure 6. Maximum and average offset vs. off-iso distance. The first standard deviation is presented with average offset. The green dashed line is the cubic polynomial fit line. The cubic function is presented on the right.
MultiMet-WL Cube // Releases July 2019

- New StereoPHAN insert
- Off-axis W/L test
- Quantifies accuracy out to 7cm off-axis
  - 0.1mm precision
- Automated Analysis with integration into SunCHECK Machine – late 2019
Summary:

- **SRS MapCHECK has been validated for Stereotactic QA**
  - Allows efficient SRS QA
  - Therefore (hopefully) encouraging more thorough QA
    - Multiple planes of analysis
    - QA for Cone-based SRS
    - QA for CyberKnife SRS

- **Most common SRS Errors found in validation:**
  - TPS small field Output Factors
  - TPS grid size
  - High complexity plans that can’t be calculated or delivered accurately

- **Multi-met single isocenter plans are the most challenging plans due to:**
  - High complexity
  - 0-1mm margins
  - Compounding off-axis rotational errors
    - Need to measure the errors for each Linac and inform the Doctor
Thank you

Questions?
Charge: To provide recommendations on the development and enhancement of quality assurance (QA) protocols for external beam radiotherapy modalities.
“We make the following recommendations for IMRT QA verification of the dose distributions (fixed-gantry IMRT and rotational IMRT):

• IMRT QA measurements should be performed using a TC (true composite) delivery method provided that the QA device has negligible angular dependence or the angular dependence is accurately accounted for in the vendor software.
  o Translation – Keep the measurement in the orientation of the patient, and use a device with negligible angular dependence

• “IMRT QA measurements should be performed using the PFF (perpendicular field-by-field) delivery method if the QA device is not suitable for TC measurements, or for TC verification error analysis.
  o Translation – For static IMRT, Field-by-Field method can be used if the device has angular dependence or can’t be used in the patient orientation (i.e. EPID)

• “IMRT QA measurements should not be performed using the PC (perpendicular composite) delivery method which is prone to masking delivery errors.”
  o Translation – Do not use devices that composite multiple beams into a 2D plane; it will hide errors.
“The PC method has the distinct disadvantage of potentially masking errors due to the summation. Regardless of the advantages of any particular 2D based method, none of the methods discussed provides information about the 3D dose deviation in the patient.”

- Examples:
  - Summation of any VMAT arc using any of these QA devices:
    - MapCHECK3 attached to Gantry
    - MatriXX attached to Gantry
    - PTW Octavius if used for 2D QA
    - Portal Dosimetry
    - PerFraction 2D
    - When fields are collapsed to Gantry 0

“Using the EPID to obtain an integrated image for VMAT is considered Perpendicular Composite”
Task Group-218 // True Composite 3D - Recommended

• The Task Group prefers 3D QA because it:
  o Covers the entire field of treatment in 3D
  o Offers a True Composite that samples throughout the field of treatment (not just in a 2D plane)
  o This method most closely simulates the treatment delivery to the patient
  o Provide an actual dose summation of the 3D dose. Only one dose image to analyze

• Examples:
  o ArcCHECK
  o Delta 4
  o 3D QA

• Ideal solution
Task Group-218 // True Composite 2D

- **True Composite – 2D (2D array left on the couch during delivery)**
- **Must have Angular Corrections**
  - For 2D arrays, only SRS MapCHECK and MapCHECK 3 have corrections
- Provides an actual dose summation in a 2D slice of the 3D dose
- Does not sample every part of each beam.
- Examples **without Angular Corrections – not recommended:**
  - MapCHECK2, MatriX, PTW 1500, any 2D arrays when left on stationary on the couch during delivery